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MACHINE AND HAND DIRECT SEEDING OF PINE
AND CEDAR IN THE PIEDMONT

By

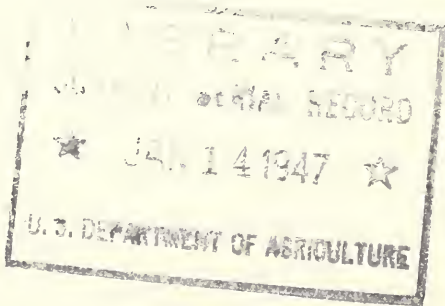
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This is a direct-seeding guide for shortleaf pine, loblolly pine, and red cedar in the Virginia and Carolina Piedmont region. It gives briefly the experimental and pilot plant^{1/} results of both hand and machine methods of direct seeding and describes the recommended methods.

^{1/}A trial area large enough to test the best experimental results, locate defects of the method, and determine costs.



Place of Direct Seeding in Reforestation

If properly done, direct seeding has a definite place in Piedmont reforestation. It has the following advantages:

1. Machine methods of seeding are much cheaper than planting trees.
2. A farmer or landowner may collect seed from his own woods, which will further reduce the cost and insure the use of local strains of a given species. It has been found that seed from "foreign" strains growing several hundred miles away may produce inferior trees with greater susceptibility to disease and insect attack and with a slower growth rate. Methods of collecting and extracting pine and cedar seed may be learned from the State Forester or State Extension Forester.
3. Because of the natural root systems, direct-seeded forest stands are likely to be superior to planted stands. This is especially true on the heavy clay Piedmont soils where roots of planted trees may easily be twisted or cramped in planting. Such root distortion usually persists and may eventually result in root rot or slower growth.
4. The use of direct seeding splits the reforestation work load. Planting is best done in early spring, whereas seeding should be done in November and December.
5. Reforestation work may be carried on even if planting stock is not available.

Establishment of forest stands by direct seeding has one particular disadvantage. Because of drought and rodent or bird damage, nearly complete failures may occasionally be experienced. Results are also likely to vary greatly in different areas for no apparent reason. In general, direct seeding is not successful on areas having dense vegetation or known heavy rodent population.

Earlier Experiments

McQuilkin^{2/} began an intensive study of pine direct seeding in 1940. Many small experimental plots were established in Virginia and

^{2/}McQuilkin, W. E. Tests of direct seeding with pines in the Piedmont region. Jour. Agr. Research 73: 113-136. August 1946.

South Carolina, and studies were continued for several years. A number of treatments and combinations of treatments were tried in the McQuilkin study. The best results were obtained by broadcast sowing of seed on a prepared spot of mineral soil which was then mulched; the spot was also screened against rodents and birds. Screening, however, was expensive, and the extra benefit did not justify the cost.

Large-scale trials of this method, without screens, showed that seeding results were likely to be erratic on different areas and in different years. Some complete failures were experienced. Costs were only slightly less than for planting. The logical conclusion was that a much cheaper method of direct seeding must be found before seeding could be recommended in place of planting. For that reason, the senior author of this note established tests of machine methods and modified hand methods on the Lee Experimental Forest in Virginia in the fall of 1943. Pilot plant tests were established in late fall of 1944.

Further Preliminary Studies

Hand and machine methods of direct seeding loblolly pine, shortleaf pine, and red cedar were tested in the 1943 studies on the Lee Experimental Forest. McQuilkin's recommended hand method was used as a standard for comparing other hand and machine methods. Because nothing was known regarding cedar direct seeding, a number of different techniques were tried for this species.

Hand Methods - Pine

1. "Standard" method. Spots of about 10 inches in diameter were prepared by scalping off the vegetation and loosening the soil. About 15 viable seeds were broadcast-sown on each spot, patted down by hand and covered with a layer of dead mulch about $1/4$ inch thick.
2. Modified method. Spots were prepared as before. Drills were made across the spot with stick or finger about $1/4$ inch deep for loblolly and $1/8$ inch deep for shortleaf pine. We sowed seed along the drill and covered with soil to depth of drill, but added no mulch. This method has the great advantage of eliminating the mulching and thus reducing the cost at least 20 percent.

The results at the end of the first season and in late July of the second summer for the 6 plots were as shown in table 1.

The drill method was superior for both species at the end of the first season but suffered greater mortality up to July of the second summer, especially for shortleaf. Seedlings in the drills were usually packed very close together. They were not thinned up to the

second summer examination and suffered greater mortality than the broadcast-sown seedlings. If the catch is good, either drill or broadcast-sown pine should be thinned to one good seedling per 10-inch spot at the beginning of the second spring.

Table 1.--Percent of hand-sown spots containing one or more seedlings

Treatment	: End first season		: July of 2nd summer	
	: Loblolly	: Shortleaf	: Loblolly	: Shortleaf
	<u>Percent</u>	<u>Percent</u>	<u>Percent</u>	<u>Percent</u>
Broadcast, mulched	<u>1</u> /60.0	50.0	50.6	40.5
Drilled, not mulched	77.8	61.7	61.1	32.2

1/ Each value is mean of 180 seed spots distributed in 6 plots.

Hand Methods - Cedar

1. Same as "standard" method for pine, except spots were screened.
2. Same as drill method for pine, except spots were screened. The use of lime on another set of plots and a coating of red lead on the seed before sowing both gave poor results. A group of plots given the "standard" treatment, except that two sides of the screens were pulled open, gave results practically as good as when screens were closed. Apparently, rodents were not an important factor in success of these plots. The slight shade may have been beneficial. Results of the two best methods are shown in table 2.

Table 2.--Percent of hand-sown spots containing one or more cedar seedlings

Treatment	: End first season		: July of 2nd summer	
	<u>Percent</u>		<u>Percent</u>	
Broadcast, mulched, screened	<u>1</u> /61.1		35.6	
Drilled, not mulched, screened	61.1		51.8	

1/ Each value is mean of 216 seed spots distributed in 6 plots.

The reason for the heavy losses on the broadcast and mulched spots is not known. Seedlings were very small, and competition in the drill would not be a factor as with pine.

Machine Methods - Pine and Cedar

Because the original methods were later improved, the detailed procedure used in our preliminary machine seeding experiments will not be given. Both flat-bottomed and V-shaped furrows were seeded with a Plantet Jr. push-type mechanical seeder. Half of the flat furrow plots were mulched in the furrows and half were not. The V furrows were not mulched. Results for both pine and cedar showed the flat furrows with mulch were much superior. Eight out of 12 pine plots were reasonably successful, as were 3 out of 6 cedar plots. Certain defects were noted, however, and corrected in the subsequent pilot plant machine seeding, where much better results were obtained.

Conclusions from Preliminary Experiments

The following pertinent conclusions were drawn from our preliminary direct-seeding experiments on the Lee Experimental Forest:

1. Hand seeding on prepared spots in a drill without mulch is as good or better than broadcast seeding on mulched spots.
2. In hand seeding there is a tendency to apply mulch too thick. Mulch should be not over 1/4 in. thick. It is better to have too little than too much.
3. Mulching adds at least 20 percent to the cost of hand seeding. Mulch, however, is probably necessary on completely bare, eroded areas.
4. Screening is expensive and does not justify the slight added success.
5. Because of the size of the seed, loblolly pine consistently gives better results than shortleaf pine. This should be counteracted by using larger numbers of shortleaf seed.
6. Pine seedlings should be thinned at the beginning of the second spring to one good seedling per spot. Thinning of cedar, if necessary, should be delayed until the plants are crowding each other.
7. V-type furrows are completely unsuitable because seed are covered too deep with soil during the winter.
8. Furrows should be wide, flat, and shallow, and plowed very nearly on the contour. Washing often covers the seed too deep.

9. Mulched furrows wash less than unmulched furrows.
10. Furrow slice should always be thrown on the downhill side to prevent loose soil from washing into the furrows.
11. No attempt should be made to cover machine-sown seed with soil. Washing and frost heaving will cover them, many too deep.

Establishment of Pilot Plants

Taking advantage of lessons learned from the previous experiments, we established larger-scale pilot plant trials to determine approximate costs of the method and to learn how the new techniques improved results. Four broomsedge areas of about an acre each were machine-seeded in early December 1944. Two areas were seeded to loblolly pine, one to shortleaf pine, and one to red cedar. The work was done by the furrow and seeder method.

A similar and adjacent area was also seeded by hand.

Costs of Machine and Hand Methods

By actual tests on the Lee Experimental Forest and by calculation, costs per acre in physical units of the furrow-seeding machine method are about as follows:

Plowing furrows 6 feet apart	1.0 team-man-hour; 1.38 miles of furrow per hour
Seeding in furrows	0.7 man-hour; 2 miles of furrow per hour
Mulch in furrows	5.2 man-hours; 0.27 mile of furrow per hour
Loblolly pine seed used	1.0 pound; 23,000 seeds per pound
Shortleaf pine seed used	0.33 pound; 69,000 seeds per pound
Eastern red cedar seed used	1.2 pound; 18,000 seeds per pound

A team-man-hour is one man with a light team, a single horse, or mule working one hour.

The hand seeding was done on an adjacent 2-acre area about three-fourths heavy broomsedge and one-fourth bare eroded ground. The hand

seeding required about 25 man-hours of labor per acre. Mulch was used on the bare ground. On the sedge-covered ground, seed was sown in a drill and not mulched. About the same amount of seed was used as for the machine method.

In a pilot-plant hand-seeding trial on 11 acres in South Carolina, McQuilkin used 18 man-hours per acre on a broomsedge area and 24 man-hours per acre on a bare area, where mulch had to be transported.

The hand seeding on the Lee was handicapped by very dense broom-sedge and frozen ground.

The analysis of costs per acre of machine and hand methods of direct seeding are shown in table 3.

Table 3.--Comparison of costs per acre, by species, for machine and hand methods of direct seeding

Method	Labor required	Seeds required	Cost
	<u>Team--</u> <u>man-hours</u>	<u>Man--</u> <u>hours</u>	<u>Pounds</u>
Machine, Lee:			
Loblolly pine	1.0	5.9	1.0
Shortleaf pine	1.0	5.9	0.33
Red cedar	1.0	5.9	1.2
Hand, Lee:			
Loblolly pine	--	25.0	1.0
Shortleaf pine	--	25.0	0.33
Red cedar	--	25.0	1.2
Hand, South Carolina:			
Loblolly on broomsedge	--	18.0	1.0
Loblolly on bare ground	--	24.0	1.0

Labor cost for a team-man-hour is figured on a basis of \$1.00 per hour. Other labor is figured at \$0.50 per hour. Cost of seed was taken at \$2.79 per pound for loblolly, \$2.06 for shortleaf, and \$2.00 for red cedar.

In the machine method, mulching in the furrows is by far the most costly labor item and it is the one item a grower could possibly omit

and still attain satisfactory results. If mulching were omitted, costs for the ~~hand~~^{machine} method would be \$4.14, \$2.03, and \$3.75 per acre, as compared with \$15.29, \$13.18, and \$14.90. Mulching may be omitted from alternate portions of seeded areas until you determine whether it is necessary in your area.

Results of Machine Methods

Good to excellent results were obtained from the 4 small areas seeded by the furrow and seeder method. Results on the area seeded by the hand method were observed to be much poorer. No formal examination was made. Results of the machine method are as shown in table 4.

Table 4.--Seedlings stocked as a result of machine method

Species	: Average spacing : : of seedlings in : : furrows :	Seedlings : per : acre :	Stocking
	<u>Feet</u>	<u>Number</u>	<u>Percent</u>
Loblolly pine, area 1	4.2	1730	82
Loblolly pine, area 2	5.6	1300	75
Shortleaf pine	9.5	765	60
Red Cedar	2.9	2500	86

The stocking figure is the percent of quadrats 8.5 x 8.5 feet, with at least 1 live seedling. If fully stocked on all quadrats, this spacing would provide about 600 perfectly distributed trees per acre with 80 square feet basal area when the average diameter of the 600 trees is 5.5 inches. Stocking on a basis of quadrats 10.5 x 10.5 feet is 91, 90, 77, and 92 percent, respectively. When fully stocked, this spacing provides 400 trees per acre with a basal area of 80 square feet when the average diameter of the 400 trees is 6.5 inches.

Recommended Methods of Direct Seeding

Seed

Seed should be viable and fairly free from trash or foreign matter. Loblolly has about 23,000 seeds to the pound, shortleaf 70,000 seeds, and red cedar 18,000. Since allowance must be made in the case of poor viability or excess foreign matter, the seed needed per acre will depend on the number of seed per pound, purity and viability. Pine should be seeded in the fall or very early spring. The seed of red cedar should be held one year in storage and always seeded in the fall. Scarification of cedar also increases germination. Any seed that is stored should be kept cool and dry in tight containers.

Hand Methods

The steps in the hand seeding method are as follows:

1. Remove sod or vegetation from a spot about 10 inches in diameter and chop slightly to loosen the soil. This can best be done with a hazel hoe or light mattock.
2. Make a drill about 1/4 inch deep across the spot with a stick or with the fingers. This should be slightly deeper for loblolly pine and red cedar and a little shallower for shortleaf.
3. Sow about 10-15 viable seeds along the drill. Loblolly and cedar should be covered with about 1/4 inch of soil and shortleaf with about 1/8 inch. Pat the soil down on the seed with the palm of the hand.
4. On bare, eroded areas, seed should be broadcast on the surface of the spot and covered with a layer of mulch about 1/8 to 1/4 inch thick. This method may also be used on vegetated areas but it is more costly and, in these tests, gave poorer results than the drill method.

Hand methods are much more costly and gave poorer results than the machine method described below. It may be necessary to use the hand method on rough or steep areas.

Machine Method

1. Plow shallow, flat-bottomed furrows about 6 feet apart on the contour 30 to 90 days before seeding. The furrows should be as shallow as possible, 2 inches is enough, and the furrow slice always thrown toward the downhill side by using a sidehill plow. Plowing furrows on the contour is important, as washing will occur if they have any appreciable slope. On the Lee pilot

plants, this was done by eye, and good results were obtained. Furrows should be plowed 30 to 90 days previous to seeding so they will have time to "settle" and so that rodent damage will be minimized. Rodents tend to explore new furrows thoroughly. The furrow slice is thrown toward the downhill side to prevent loose dirt from washing into the furrow.

2. Seed the furrows in the fall or very early spring with an ordinary push-type mechanical seeder (Plantet Jr. type). Set the seeder so it will drop about 3 viable seeds per linear foot for loblolly and cedar, and 4 for shortleaf. The seeder may be run along the bottom of the furrow at a fast walking pace. In machine seeding, the seed should not be covered with dirt but merely dropped in the bottom of the furrow. Seed will be amply covered by frost and water action. The mechanical seeder is used to obtain fast, accurate, and even distribution of seed. (The furrows could also be seeded by hand but this job should not be entrusted to ordinary labor, as pine and cedar seed is expensive and it could easily be wasted. Hand seeding would also be much slower.)
3. Rake a very light mulch of dead grass or debris into the bottom of the furrows from the upper side. This can best be done with a fire rake or other type of broad-tooth rake. This mulch should be very light, not over 1/4 inch deep at any point. Thick bunches of mulch must be avoided as they will smother the germinating seedlings. No mulch at all is better than too much mulch. Quick, light strokes of the rake serve best to scatter a little mulch in the bottom of the furrows.

Alternating portions of the area should be left unmulched for the first few seeding operations, to determine the real necessity of mulching for different places.